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(71) Applicant *(for all designated States except US)*: **BOOKHAM TECHNOLOGY PLC** [GB/GB]; 90 Milton Park, Abingdon, Oxfordshire OX14 4RY (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **TODD, Karen, Emma** [GB/GB]; 39 Argyle Street, Oxford OX4 1ST (GB). **THURMAN, Philip, John** [GB/GB]; 66 Vicarage Road, Oxford OX1 4RE (GB). **EYMIN-BALZANO, Gregory, Joel, Rue** [GB/GB]; 42 Marsh Road, Oxford OX44 9LP (GB). **TYLER, Stephen, Geoffrey** [GB/GB]; 5 Ballard Close, Abington, Oxfordshire OX14 1XQ (GB).

(74) Agents: **DOWNING, Michael, Philip** et al.; Fry Heath & Spence, The Old College, 53 High Street, Horley, Surrey RH6 7BN (GB).

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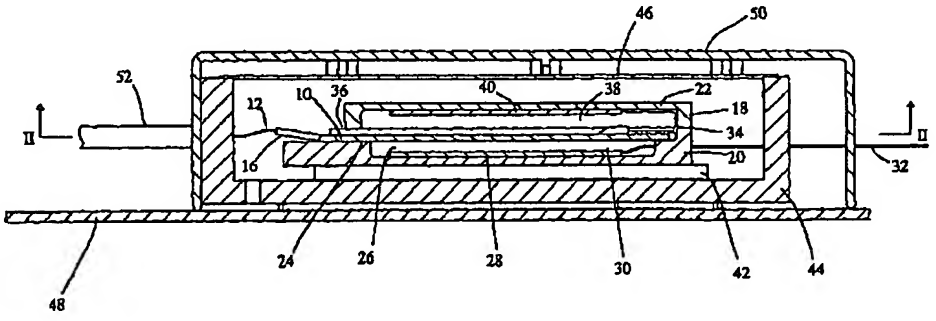
(54) Title: HEATED INTEGRATED OPTICAL DEVICE PACKAGE



(57) Abstract: An integrated optical package comprises an integrated optical device, a pair of planar heaters disposed on either side of the device, the heaters being separated from the device by a fluid gap. This can be provided within a supporting structure comprising a base part and a lid part, the base part having a hollowed region in which is disposed one heater and a ledge surrounding the hollowed region in which the device is supported, the lid having an interior surface carrying the second heater. The arrangement allows for greater thermal stability, particularly in the presence of air flows. The fluid gap is preferably less that 3mm, more preferably 2mm or less. The fluid gap is also a suitable location for a thermistor for regulating the heater output.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HEATED INTEGRATED OPTICAL DEVICE PACKAGE

FIELD OF THE INVENTION

The present invention relates to the packaging of integrated optical devices. It particularly, but not exclusively, addresses the problem of holding the device within a protective package and in combination with heating elements that allow it to operate within a specified range of temperature, and in such a way as to avoid or eliminate stresses on the device during operation.

BACKGROUND ART

Many integrated optical devices operate through the interference of guided light and therefore demand close dimensional stability if they are to operate reliably. Heating elements and a controlling thermistor are therefore incorporated into the package in order to raise the operating temperature of the device above ambient to a reliably achievable temperature. A range of 70 to 75°C is commonly selected.

The continued integration of optical processing devices results in demands that they operate in close proximity with other conventional electronic devices. These often involve cooling apparatus designed to direct a flow of cooling air, which will interfere with the heating of the optical device and could cause

undesirable temperature fluctuations. The device also needs to be protected from temperature gradients, regardless of the external environmental conditions. For this and other reasons, it is desired to provide a package capable of more stable control of temperature.

SUMMARY OF THE INVENTION

The present invention therefore provides an integrated optical package, comprising, an integrated optical device, a pair of planar heaters disposed on either side of the device, the heaters being separated from the device by a fluid gap.

This can be provided within a supporting structure comprising a base part and a lid part, the base part having a hollowed region in which is disposed one heater and a ledge surrounding the hollowed region in which the device is supported, the lid having an interior surface carrying the second heater.

The reference to a "fluid gap" in this application is intended to refer to a gap which is filled with a fluid able to conduct heat from the heater to the device. This will normally be air or an inert gas such as nitrogen or one of the noble gases, typically argon. Electrically insulating fluids such as silicones and the like are also suitable.

Suitable heaters for such an arrangement are formed by a layer of deposited resistive material. This can be laid on the surface of the supporting structure, which can for example be of a ceramic material.

The fluid gap acts as a thermal conductor which brings the device to the intended temperature. The physical disposition of the heaters on either side of the device limits the effect of airflow on the temperature of the device by shielding the device.

A suitable fluid gap is less that 3mm in order to limit the effect of convention currents. A more preferred fluid gap is 2mm or less, at which point heat transfer is substantially entirely by way of conduction and radiation. The fluid gap is also a suitable location for a thermistor for regulating the heater output.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described with reference to and/or as illustrated in the accompanying figures, in which;

Figure 1 is a vertical section through a integrated optical package according to the present invention; and

Figure 2 is a horizontal section on II-II of figure 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring to figures 1 and 2, an integrated optical device 10 is provided, in the form of a silicon wafer with an appropriately etched and/or doped structure thereon. It is supplied with an incoming optical signal via an optical fibre 12 and, in this case, returns an outgoing processed signal via a further optical fibre 14. The fibres are each connected to the device 10 via a fibre block such as at 16.

The device 10 is supported in a ceramic block 18 such as macor formed of a lower shell 20 and an upper shell 22. The lower shell 20 has an inner ledge 24 on which the device 10 rests, and within which there is a lower recess 26. A lower heater 28 is deposited on the interior surface of the recess 26, formed of a layer of resistive material such as a thin aluminium layer. This therefore faces the underside of the device 10.

The upper shell 22 rests on an outer ledge 34 which surrounds the inner

ledge 24 in three sides and is higher by a height greater than the thickness of the device 10. Thus, on the fourth edge 36 the device 10 can protrude beyond the lower edge of the upper shell 22 to allow for the fibre blocks 16 or other attachments for the fibres 12, 14.

An upper recess 38 is formed on the internal face of the upper shell 22, facing the device 10. An upper heater 40 is formed on the inner face of the upper recess 38 in like manner to the lower heater 28. The two heaters 28, 40 are controlled by the control circuitry in response to the thermistor in order to maintain a predetermined temperature around the device 10, such as one in the range 70 to 75°C. A thermistor 30 is provided on the device 10, and thus located within the upper recess. It communicates with external control circuitry (not shown) via a cable 32 which also serves the heaters 28, 40.

The entire assembly is supported by spacers 42 in a receptacle 44. This is sealed via a lid 46 which can be hermetically sealed if necessary. The receptacle is in turn fixed to a substrate 48 and provided with physical protection via a cover 50. Suitable conduits and grommets 52 allow entry of the optical fibres 12, 14.

This arrangement forms an oven around the device 10 which is straightforward to manufacture but able to maintain a steady temperature even in the presence of airflow. This is becoming an important factor, as mentioned above, due to the use of integrated optical devices in the vicinity of electronic equipment. Such equipment does of course require cooling, and this is usually by way of a forced airflow.

The gap between the device 10 and the respective upper and lower heaters 40, 28 is not especially crucial to the invention provided that there is a distinct layer of air or other fluid to allow for conduction laterally as well as transversely to the gap, and provided the gap is not so large as to allow other effects which may cause unevenness in the heating. For example, if the gap is greater than 3mm then

this can in some cases cause convection currents to develop. A gap of 2mm or less is recommended. A gap of this size also allows sufficient clearance for the thermistor to be incorporated in the gap, thereby giving a more accurate response.

The device 10 is attached to the underlying support along two or three edges as set out in our concurrently filed application entitled "Packaging of Integrated Optical Devices". A layer of adhesive is provided between the surface of the ledge and the underside of the wafer to fix the wafer in place along the relevant edges. A suitable adhesive is Resintec™ RT125, a low stress epoxy which cures at 80°C. This is close to the operating temperature of the device, at 70 to 75°C. Accordingly, when operating, the resin adhesive is close to the temperature at which it cured and has little or no residual stress which would otherwise be exerted on the wafer. In addition, the low stress nature of the resin adhesive means that it retains some resilience after curing, which assists further in absorbing any residual stresses in the adhesive or the wafer.

The adhesive is provided in a series of elongate stripes of between 1 and 10mm wide, typically 2mm. These lie along the ledges which support the device edges. Alternatively, the adhesive could be spotted along those ledges so as to fix the two or three edges.

Since the fourth edge of the wafer (and possibly a third edge) is free floating and unattached, it can move slightly to accommodate any residual stresses. This means that the material at that edge and in an area behind it will be still more free of stress. This area can be designed to substantially cover the active region thereby allowing the device to operate accurately.

It will of course be appreciated by those skilled in the relevant arts that the above-described embodiment is presented purely by way of illustration of one manner of employing the present invention. Many variations are possible without departing from the scope of the present invention.

CLAIMS

1. An integrated optical package, comprising;

an integrated optical device

a pair of planar heaters disposed on either side of the device;

the heaters being separated from the device by a fluid gap.

2. An integrated optical package according to claim 1 within a supporting structure comprising a base part and a lid part,

the base part having a hollowed region in which is disposed one heater and a ledge surrounding the hollowed region on which the device is supported;

the lid having an interior surface carrying the second heater.

3. An integrated optical package according to claim 1 or claim 2 in which the heaters are a layer of deposited resistive material.

4. An integrated optical package according to claim 2 or claim 3 in which the supporting structure is of a ceramic material.

5. An integrated optical package according to any preceding claim in which the fluid gap is less that 3mm.

6. An integrated optical package according to any preceding claim in which the fluid gap is less that 2mm.

7. An integrated optical package according to any preceding claim in which a thermistor is located in the gap and the heaters are controlled in response to the feedback of the thermistor.

8. An integrated optical package substantially as herein described with reference to and/or as illustrated in the accompanying figures.

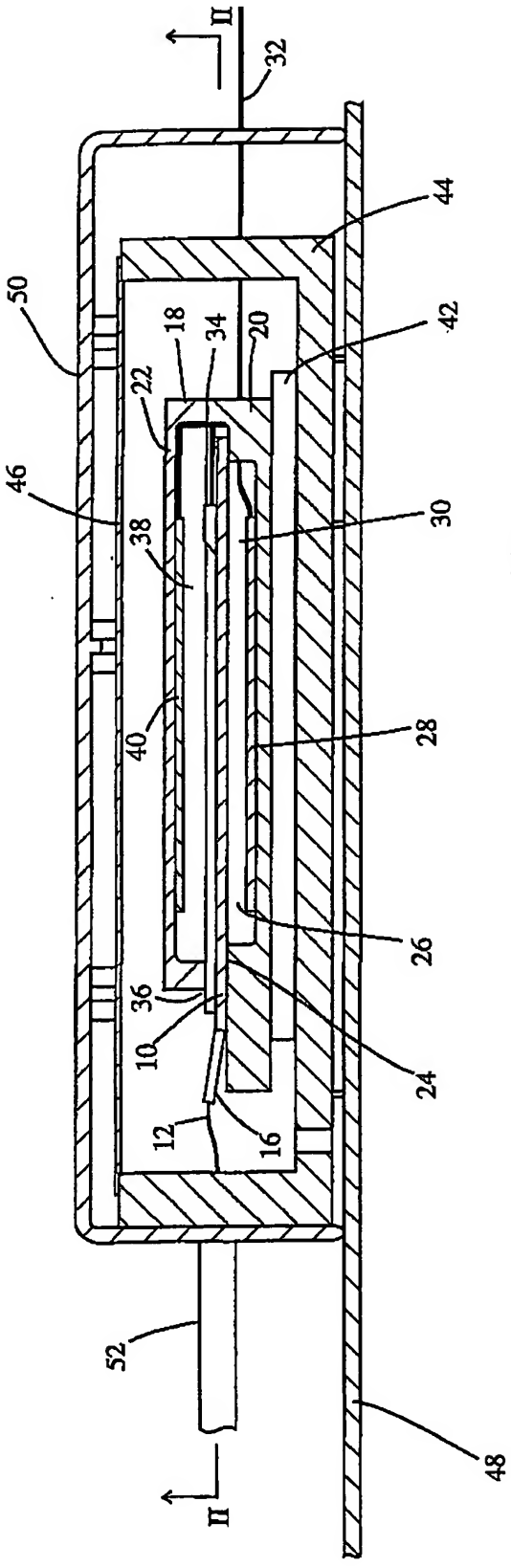

Fig 1

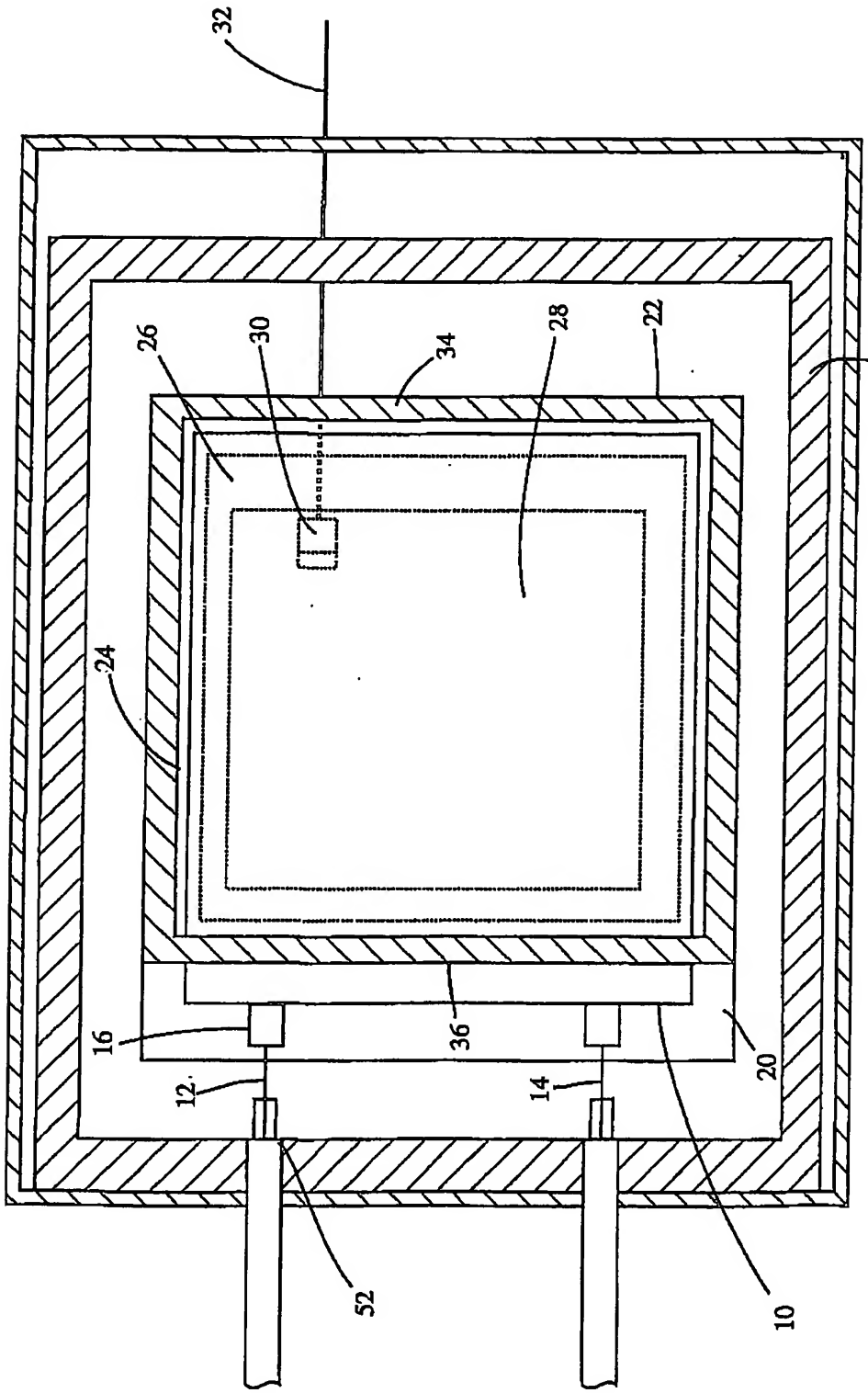

Fig 2

INTERNATIONAL SEARCH REPORT

PCT/GB 01/04657

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B6/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) & JP 11 281826 A (FURUKAWA ELECTRIC CO LTD:THE), 15 October 1999 (1999-10-15)	1,7
Y	abstract; figures 1,2,4	1,3,5,6
Y	US 5 131 062 A (EIDE JOHN E ET AL) 14 July 1992 (1992-07-14) abstract; figures 2,3 column 3, line 19-22 column 4, line 45-50	1,5,6
Y	US 5 919 383 A (SCOTTA FELICE ET AL) 6 July 1999 (1999-07-06) abstract; figures 3,4 column 2, line 46-53	1,3

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 March 2002	20/03/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Beaven, G

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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